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lectures in English on mining telecommunications equipment in China by Chief Engineer Gerhard Thuerling of Alt-Friedrichsfelde 126 in Berlin-Friedrichsfelde and by Engineer Stimper (fnu). The equipment applies to both open-pit and underground mining. In the introduction reference is made to the fact that VEB Funkwerk Koepenick in East Germany is producing such equipment.

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INFORMATION REPORT INFORMATION REPORT

Reporter: (Chief Engineer Dr.) Gerhard Thürling,
German Democratic Republic, Berlin.
Berlin-Friedrichsfelde
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126

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Subject:

"New Electric Mining Appliances and Signalling Installations Using Special Constructional Parts"

Report No. 1:

"Special constructional parts and electric switch devices for above and under ground mining."
(Rotary transmitters, Ferrari systems, and relays)
(General expositions for the experts in open digging above and under ground).

Report No. 2:

"Electric appliances and signalling installations for mining above ground"
(concerning conveying bridges, dredging machines and other large hauling plants)
(Particularly for the experts in open digging).

Report No. 3:

"New electric signalling installations for under ground mining"
(old and new-fashioned systems of signalling installations for the shafts of mines).
(Particularly for the experts in under ground mining of ores, coal, and potassium).

Ladies and Gentlemen, Dear Comrades,

I consider it a special honour and pleasure to come and to see your country. My technical report on the topic:

"New electric mining appliances and signalling istallations consisting of special constructional parts"

intend to assist you in your efforts aiming at the use of modern technics, in special respect to the mining industry, in favour of your national economy. We are firmly resolved to offer you the assistance of the German Democratic Republic, thus contributing, to a small extent, to the fulfillment of your economical plans and to the peaceful progress of your nation.

It is our task to inform you in the special branch of "mining industry" about new-fashioned communication installations. The German Democratic Republic is producing - partially in our works "Funkwerk Berlin-Köpenick" - such installations.

After my departure the engineers of the Commercial Section to the Embassy of the German Democratic Republic will be able and readily willing to go on to advise you in the special branch of mining industry particularly in respect to the new communication installations.

And now I beg to speak of the technical matters concerned.

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"The Rotary Transmitter and its Use for Mining Work"

by Engineer Stimper

As everybody knows, the constructional industries of communication engineering are using nowadays special constructional parts for solving the problems put to them. I beg to pick out one of the numerous constructional parts in question: the Rotary Transmitter.

The rotary transmitter is used predominantly for the remote transmission and indication of positions resulting from rotating or reciprocating movements, e.g. from the operation of control levers and switches respectively, of a valve, slide valve etc.

The rotary transmitter has already and always turned out best in long years periods of use in ships and manifold industrial branches, due to its simple and robust construction as well as its reliable work. In this way it has become an indispensible constructional part of communication engineering in any case where continuous and practically undelayed electric transmissions of angular values, resp. orders are required. For some time past, therefore, the rotary transmitter has been successfully introduced also in mines above and under ground.

The rotary transmitters are normally rated for a voltage of 110 V with 50 cycles. In special cases resulting from the working conditions in question, and on request the rotary transmitters can be supplied with ratings for other voltages and frequencies, and for direct current, too. Not being sensitive against varying voltages and frequencies they are still reliably working even at voltages varying between +10 % and -15 %, and at frequencies subject to variations of ±5 %.

The rotary transmitter represents a high-valued constructional part owing the nature of a measuring device. This is why it must be absolutely protected against the entrance of dust and moisture by accommodating it in a suitable casing.

Now I beg to explain, by showing you the following diapositives, the details of design, operation, and some examples of application of the rotary transmitter.

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In mechanical and electrical respect the rotary transmitter is of motor-like design. Its picture can be found in our special prospectus. The substantial part of this transmitter is a stator provided with a three-phase winding and bearing a single phase wound rotor. On the bearing block a board of knife contacts for the electric connection is fitted, thus simultaneously permitting a quick replacement of the rotary transmitter. Two guide pins secure a satisfactory fit. 25X1

The voltage for the single phase winding is fed through silver brushes and slip rings; with a view to the accuracy of indication the contact pressure is kept as small as possible.

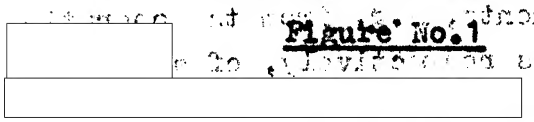

Figure No.1

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1 - Connection board;
2 - Rotor, complete;
3 - Ball bearing;
4 - Bearing shield;
5 - Current collector;
6 - Bearing block;
7 - Stator;
8 - Rotary transmitter;
9 - Rotary transmitter, assembled and diamantled.

Rotary Transmitter, assembled and dismantled.

shows the individual parts of the rotary transmitter, consisting substantially in the stator frame with the inserted guide pins, the complete rotor with the slip rings, the ball bearings for the rotor, the bearing shield, and the board of knife contacts simultaneously bearing the brushes. The appropriate connection board (spring board) is separately supplied together with the rotary transmitter.

The stator frame, bearing shield, and the bearing block are made of a seawater resistant light metal alloy in order to prevent any corrosion to a large extent. 25X1

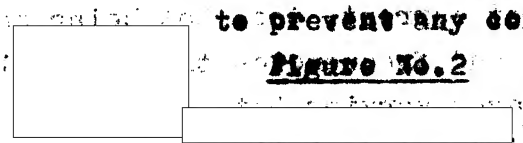

Figure No.2

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1 - Bearing shield;
2 - Stator core;
3 - Bearing block;
4 - Current collector;
5 - Slip rings;
6 - Stator core;
7 - Ball bearing;
8 - Stator winding;
9 - Casing with flange;
10 - Section through the Rotary Transmitter

Section through the Rotary Transmitter

represents the section through the rotary transmitter, showing the individual parts in assembled condition. The frame bears the stator core with its three-phase winding. The bearing shield and the bearing block, also accommodating the the ball bearings for the motor are closing the casing. For reducing the existent eto effect the armature core plat

is provided with inclined slots, thus also minimizing the setting error.

The rotary transmitters are divided into signalling and receiving sets. Both are of same electric and mechanical construction, differing only as to the size which, for the signalling set, depends on the number of receivers to be operated and on the torque required by the receiver shaft respectively.

The rotary transmitters have been already produced for years. The present production comprises smallest rotary receivers of type 70/80 and largest rotary signalling sets of type 120/155. These type numbers simultaneously also indicate the size of the set, the first figure referring to the diameter, and the second one to the total length of the rotary transmitter; in this way the type 70/80, for example, corresponds to a diameter of approximately 70 mms, and to a total length of about 80 mms.

Figure No.3

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1 - Stator (three-phase winding);
2 - Rotor (excitation;
3 - Principal wiring;
4 - Signalling set;
5 - Receiving set;
6 - Receiver rotor (turned by 30 degrees);
7 - Direction of the alternating field;
8 - Rotor; 9 - Stator;
10- Voltage run in the three-phase winding;
11- Rotary Transmitter.

The upper part of the picture shows sections through the windings, and that at the outside the three phase windings (three-phase winding) staggered by 120 degrees, and the inside rotor winding (excitation). One transmitting unit consists of not less than 1 rotary signalling and 1 rotary receiving set. The three-phase windings of the signalling and the receiving set are electrically connected by three conductors. To the single phase winding an A.C.-voltage of 110 V and 50 cycles is applied.

Rotary Transmitter

By means of the excitation winding magnetic alternating fields are formed inducing in the stator winding an electromotive force (e.m.f.) which, according to the position of the rotor, is reaching different values in the three phases of the stator. Yet if the rotor of the rotary signalling set is manually or mechanically turned by a certain angle, in this way the direction of the alternating fields is varied, too. Caused

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by the resulting electromotive force an equalizing current will flow making the rotor of the rotary receiver follow the turn. The equalizing currents are flowing until the rotor of the receiver is adjusted to the direction of the magnetic flux transmitted by the signalling set, i.e. to the position of the latter, and, in this way, the rotor of the receiver is stopped in the same angular position as that of the rotor of the signalling set. From the lower part of the picture you may gather the sine-shaped voltage run in the three phase windings staggered by 120 degrees, in dependence on the rotor angle.

The maximum phase voltage amounts to 110 volts. 25X1

Figure No.4

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1 - Steepness;
2 - Rotary Transmitter - Torque Characteristic;
3 - Degrees.

Rotary Transmitter Torque Characteristic

The flowing equalizing currents cause a torque at the rotor, representing a function of the deflection angle α. The torque is proportional to the sine of the deflection angle so that the torque characteristic, plotted above the deflection angle, is of sinoidal shape. The steepness S results from the proportion $\Delta M : \Delta\alpha$. In order to attain upon small deflection, an utmost torque and, in this way, a satisfactory adjustment a very steep ascendence of the characteristic should be aimed at.

The connection of the rotary transmitters is indicated in the wiring diagrams listed in our prospectus. The upper part of the representation shows the principal wiring diagram, the middle the connections as used in the circuit diagrams, and the lower part illustrates operation schemes. The rotary transmitters are represented by circles with hatched signalling sets. The triangle to be seen within the circle denotes the indicator. The connection of additional receivers depends on the size of the signalling set. To the signalling set of type 90/145, for instance, five receivers may be connected, thus permitting simultaneous indications of measured values at different and locally separated places.

Examples of connections, according to the prospectus.

There are given two examples concerning the installation of fuses as used in practical service. In plain installations with one receiver only the excitation voltage line is provided with fuses. Larger and special installations, however, can have fuses, in addition, also for the three phases of the individual receivers. Such fuses are required, for instance, if the failure of the whole installation upon one receiver failing is to be prevented so as to maintain the satisfactory work of the remaining sets. The feed voltage is not to be taken immediately from the network but only through an isolating transformer or an othet suitable transformer with galvanically separated windings.

Figure No.5

1 - Rotary signalling set;
2 - Rotary receiving set;
3 - Position Indication of a Valve.

Position Indication of a Valve

After the construction and operation of the rotary transmitter have been explained in short words I beg to show you now some examples of its manifold application. Firstly the position indication of a valve as used e.g. in long distance gas or water lines. In such case the rotary transmitter is mechanically connected, through a gear wheel, to the handwheel of the valve. The ratio between handwheel and signalling set should be practically selected so as to the full operation of the valve corresponding to a deflection of the signalling set by about 180 degrees. For symbolizing the indication at the receiver the normal pointer may be replaced by a circular disk with one black and one red or white half. If also one half of the receiver dial is correspondingly covered the coled valve will make visible the black part of the disk only. As soon as the valve is opened the motion of the rotary signalling set by an angle corresponding to the extent of the opening if the valve is transmitted to the receiver. By this deflection a coloured (red or white) sector will become visible on the receiver dial size of which symbolizes the extent of the opening of the valve. In this way the remote indication of valve positions in control stands

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etc. can be effected. When using copper conductors with a cross sectional area of 1.5 mm^2 the signals given by a rotary transmitter directly connected to the receiver can be transmitted up to a distance of 1500 ms. The accuracy of indication is ±1.5 angular degrees, this figure being the mean value basing on a long years service.

The use of a new rotary transmitter, however, entails a higher accuracy of indication amounting to about ±1 degree.

Figure No.6

(- [redacted] -)

1 - Signalling set;
2 - Receiver and adding device;
3 - Rope Balance with Remote Indication through Rotary Transmitters.

Rope Balance with Remote Indication through Rotary Transmitters

Another example of application we may recognize when consid 25X1 the rope balance with remote indication by means of a rotary transmitter. When lifting a load the tension of the rope remo s the rack from its rest and neutr position; through a gear wheel the rack operates the signalling set and turns it round by an angle corresponding to the load. The necessary counter torque is achieved by a measuring spring. The synchronized receiver is turned by the same angle, thus operating the connected adding device. In this way the lifted weight is immediately measured, indicated, and simultaneously added.

Figure No.7

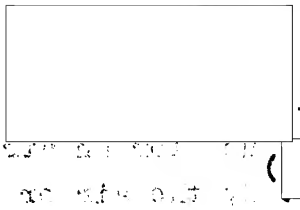
[redacted] -)

1 - Projector lamp;
2 - Condenser;
3 - Lens;
4 - Dial plate;
5 - Screen;
6 - Rotary receiver;
7 - from signalling set;
8 - Frame Repetition Device, Controlled by a Rotary Transmitter

Frame Repetition Device, Controlles by a Rotary Transmitter

The frame repetition device 25X1 shown by this picture is already practically used for the signal column as developed and produced in the people's own factory "Funkwerk Berlin-Köpenick". The shaft of the rotary receiver bears a dial plate provided, in our case, with numerals. Using a projector lamp and a condenser the numeral in question is projected through a lens on the screen. If practical, the numerals of the dial plate may be replaced by letters or other symbols.

Figure No. 8



1 - Rotary receipt receiver;
2 - Order;
3 - Rotary signalling set;
4 - Rotary receipt signalling set;
5 - Receipt;
6 - Rotary receiving set;
7 - Transmission of Orders with Receipt by Means of Rotary Transmitters.

Transmission of Orders with Receipt by Means of Rotary Transmitters

The working safety sometimes requires a given order to be confirmed by the receiving place. For such purpose the schematically shown order transmission equipment with receipting device may be applied. Both for the transmission of orders and for confirming their receipt rotary signalling and receiving devices are used. When adjusting the order lever, which is mechanically connected with a rotary signalling set, to a certain position, the order is transmitted to the rotary receiver, and indicated on a dial. The receipt is confirmed by adjusting the receipt lever, being also mechanically connected with a rotary signalling set, to the given order, thus bringing the pointers of both the ordering and the receiving device into coincidence again. The receiving set is provided, in addition, with a contact device closing, when a new order is given, a signalling circuit operating a horn or a bell. In this way the change of orders is indicated both optically and audibly. By means of the audible signalling device the equipment may be used even under noisy working conditions, thus essentially contributing to an increased working safety. The order transmission equipment scheme of which is shown in this picture is already in use within the rotary transmitter shaft signalling installations for mines, and has turned out extraordinarily well. When used for rubbish conveying bridges, this equipment serves for the communication between the drivers' stands on the dredging and the dump side. Apart from this, the equipment has been successfully used for years past also in ships and large power plants.

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Figure No.9

(- [redacted] -)

1 - Air pressure indicator;
2 - Indicator of the set of wind;
3 - Measuring spring;
4 - Rotary signalling set;
5 - Rotary signalling set;
6 - Indication receiver;
7 - Recorders;
8 - Air Measuring Equipment.

Another application of the rotary transmitter is its use for an air pressure recorder. By the air pressure acting on the dishes of the cross arms the latter are turned by an angle proportional to the pressure, resp. the speed of the air. The required counter torque is effected by a measuring spring. The angular value is transferred, through a reducing gear, to a rotary transmitter with connected indication receivers and recorders respectively.

Air Measuring Equipment

As to the indicator of the set of winds, the vane turns round according to the varying directions of the wind. The changing positions of the vane are also transferred to a rotary signalling set and, in this way, indicated by the connected receiver, or registered by the recorder. The air measuring equipment is predominantly used as safety-technical installation for large scrapers such as rubbish conveying bridges, loading bridges, putting down machines, cranes, etc. 25X1

Figure No.10

[redacted] -)

1 - Rotary transmitter;
2 - Waxed paper strip;
3 - Rotary Transmitter Recorder

For registering the measured values in this case for the speed of air, a rotary transmitter recorder of the shown type is used. Basing on the angular deflection of the rotary receiver, and through a gear wheel and a rack the recording carriage is moved in linear direction. The records are engraved into waxed paper, and for this reason any special attendance, as generally required for ink recorders, may be omitted. Apart from this the waxed paper recording method offers the considerable advantage of permitting the recording of the measured values, without special heating of the device, down to a temperature of about - 20°C. The conveyance of the paper strip with a speed of 60 mms/hr is effected by a clockwork.

Rotary Transmitter Recorder

Figure No.11

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1 - Rotary transmitter;
2 - Waxed paper strip;
3 - Rotary Transmitter Recording Device

Rotary Transmitter Recording Device

shows another rotary transmitter recording device as used in sets for recording the direction of the wind. The vane turning allround also the recording device must be capable of doing so. The recording device consists of 6 recording arms arranged in angles of 60 degrees round a turning disk which is driven by the rotary receiver through a stepping down gear of ratio 1 : 6. In this way an entire revolution of the rotary transmitter will cause a 60 degrees deflection of the recording device corresponding to a change of the wind from the north through the east, south and west to the north.

Also in this case the measured values are recorded on a waxed paper strip.

Figure No.12

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1 - Set of the wind; degrees;
2 - Related to the longitudinal axis of the bridge.

Dial for Indication of the Set of the Wind

The use of the wind measuring equipment predominantly for rubbish conveying bridges and similar large scrapers has been already mentioned. Such rubbish conveying bridges are constructions running, by means of special travelling gears, on railroad tracks. The direction of the bridge, therefore, is not variable. As to the working bridge, however, it is not important to measure the set of the wind in relation to the geographic direction but in respect to that of the longitudinal axis of the bridge. The dial of the indicator of the set of wind has been designed in accordance to this requirement, showing, as a symbol, the lattice structure of the bridge. The set of the wind, related to the longitudinal axis of the bridge, is indicated by the position of the pointer corresponding to that of the vane. In this way the angle under which the wind is acting on the bridge construction can be readily seen.

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Figure No.13

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1 - Accuracy of indication with rotary transmitters including an error of 1,8 degrees;
2 - 3-fold Rotary Transmission - Principal Example.

3-fold Rotary Transmission - Principal Example

In cases where the accuracy of indication prevailing between rotary signalling and receiving sets and amounting to about 1,5 degrees is not sufficient or the reading accuracy not favourable enough the 3-fold rotary transmission as shown in this picture may be applied. According to this principle the left rotary transmitter is signalling the fine values, the middle one the medium figures, and the right one the coarse values. As example the indication of liquid levels in containers has been selected. The diameter of the rope sheave in this case is dimensioned to one turn (revolution) of the rope sheave corresponding to 0.1 mm difference in elevation. When the level changes the rope connected with the float makes the rope sheave - and simultaneously also the fine value transmitter - turn by the corresponding angle. This turn is transferred by a gear - in our case of a stepping down ration of 1 : 10 - to the medium and coarse value transmitter. According to the assumed transmission error of 1.8 degrees the indication accuracy on the coarse value receiver is 5 cms, that on the medium value receiver 5 mms, or that on the fine value receiver 0.5 mm. You may gather from this example that by means of multiple rotary transmission the accuracy of indication can be generally and considerably increased.

In the examples of application mentioned up to now the signalling and the receiving rotary transmitters were used for the electric transmission of angular values. But it is possible too, to effect electric additions or subtractions of angular values by means of rotary transmitters. As to wiring and connections please see our prospectus. For adding, resp. subtracting electrically transmitted values besides the already known signalling and receiving rotary transmitters additional so-called differential rotary transmitters are used. These sets are substantially of same mechanical construction as normal rotary transmitters. The rotor of the differential rotary tra

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mitter, however, bears a three-phase winding. The upper part of the picture shows the principle of a differential connection. The three-phase rotor winding, resp. stator winding of the differential receiver is connected with the three-phase stator winding of a normal rotary transmitter. When forming the difference the connection of the rotary transmitters is coincident in phases. The formation of the difference results from the function a - b. If the signalling transmitters "a" and "b" are in same position the difference will be equal to zero. Yet as soon as the signalling set "a" is removed from its neutral position yb an angle of let us say 50 degrees the rotor of the differential receiver will turn by the same angle. If, apart from this, the signalling set "b" is turned in the same direction by 30 degrees this value will be subtracted and the remaining balance of 20 degrees indicated on the differential receiver. Additions, on the contrary, are effected by exchanging the phases x and z on the receiving and the signalling set respectively. In the event of a deflection of the signalling set "a" by let us say 30 degrees, the rotor of the differential receiver will follow this motion by the same angle. If now the signalling set "b" is turned - in the same direction of rotation - by 60 degrees this value will be added and the total of 90 degrees indicated on the differential receiver.

The differential receiver may be also used, in connection with only one signalling set, as normal indicating receiver, and that by connecting the three phases of the rotor with that of the stator in parallel. Upon this connection the rotor of the receiver is turned by the double value of the deflection of the signalling set, i.e. the deflection of the signalling set by 40 degrees will make the receiver deflect by 80 degrees. This connection is suitable for cases where it is desireble to obtain - without the use of additional gearings - larger indication ranges from but little moving signalling sets.

Figure No.14

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The prevailing application of the differential rotary transmitter is its use for the indication of differences between positions. The picture shows a loading bridge equipped with remote indication of the loading depth and the inclined position of the bridge.

Figure No.14

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1 - Inclined position receiver (differential rec.);
2 - Double loading depth signalling set a) fine, b) coarse;
3 - Loading depth receiver a) coarse, b) fine;
4 - Track signalling sets;
5 - Remote Loading Depth and Inclined Position Indication.

Remote Loading Depth and Inclined Position Indication

The installation indicating inclined positions of the bridge includes two track signalling sets and one differential receiver which is located in the driver's cab. The installation serves for indicating and limiting inclined positions resulting from not synchronously running travelling gears or from the slip of the driving wheels. The track signalling sets are turned - through a chain drive operated by one special measuring wheel each running on the rail - by an angle which is proportional to the way put back. In order to prevent any slip of the measuring wheels in the event of coarse weather they are sufficiently pressed to the track rails. If there are fluctuations in the synchronism of the travelling gears the resulting electric values are transferred to the differential rotary transmitter installed in the driver's cab. The rotor deflects according to the difference of the measured values, thus indicating on a dial the inclined position of the bridge. Adjustable contact dogs fitted on the differential receiver actuate, in the event of a certain extent of inclined position being exceeded, corresponding sets of spring contacts releasing an audible signal, resp. interrupting the voltage sup: to the travelling gears. The contact dogs and the spring contacts can be designed, furthermore, so as to permit to disconnect, in case of inclined position of the bridge, the driving motor of the outrunning travelling gear. In this way the motor of the lagging travelling gear is going on working and makes it come up with the other one. In this moment the disconnected motor is automatically switched on again, and bot travelling gears are uniformly driven again. This contact control effects a continuous work of the bridge since in the event of an inclined position always only one driving motor is switched off and, in this way, any standstill of the bridge obviated. For industrial purposes this kind of connection has been already successfully used, too.

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For the represented loading depth remote indication a double rotary transmission has been selected with the rope running over a measuring roller mechanically connected with the fine value transmitter. Between the fine and the coarse value transmitter a suitable gear for stepping down the speed is installed. The appropriate receiving sets are also accommodated in the driver's cab, permitting the crane driver to recognize continuously the position of the load hook at any time. This indication is of special importance in cases where the sight of the crane driver is obstructed. Also for lifting and transporting large and bulky workpieces, e.g. by two cranes inclined position of which must not exceed rather narrow limits, this installation has become an indispensible equipment. The additional use of a differential receiver with contact control indicates incidental differences between the load hooks of the own and the other crane, simultaneously also controlling the driving motors according to the already mentioned manner.

In this connection also the transmission of power by means of rotary transmitters should be pointed out. Our smallest rotary transmitter of type 70/80 permits a maximum torque of 90 cms/g. and our largest type 120/155 such of about 1000 cmg. For thermal reasons higher loads are not admissible. When transmitting power, however, an angle-coincident position between the rotary signalling and receiving sets is not longer warranted, due to the load of the receiver. The receiver, therefore, will lag against the signalling set by about 10 degrees. In cases where the output is not sufficient or the indication too coarse motors are predominantly used as adjusting and come-up-motors respectively. As to this please refer to our special prospectus.

The shown motor is an induction motor working according to the Ferrari-system, and that a single phase A.C. motor without slip rings and without collectors. The excitation and the control windings are inserted staggered by 90 degrees. The rotary field is produced by a phase capacitor connected in the excitation or control circuit. The speed increases nearly linearly with the the control voltage of the motor which fact is of special importance for control engineering. The motor consists of a thin-walled, shaped aluminium globe poor in inertia. Due to this low moment of inertia the reversal from clockwise to anti-clockwsie run at a speed of about 2500 rpm

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can be managed, without difficulties, within a quarter of a second in which time the full speed is reached again. The motor, moreover, may run under high voltage and speed against a stop and remain there without being damaged. The torque produced by the rotor globe may be discharged through a suitable stepping down gear. This gear is immediately attached to the motor; in this way both parts are united to one constructional unit.

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The Ferraris motors are produced in various sizes, and for mains voltages of 110 V, 50 cycles and 110 V, 500 cycles respectively.

The advantages the Ferraris motor offers have made him an indispensible constructional part for the communication and control engineering.

Besides the rotary transmitters especially in signal installations for mining shafts also relays of different types are used. Among them the so-called round relay is used as intermediate relay particularly for signal and control equipment It is produced for A.C. and for D.C. The three change-over contacts are rated for a continuous current of 5 A, and suitable to a high switch frequency. The number of admissible switchings ranges at about 10 millions connections with about 2000 connections per hour. The relay may be mounted in any position, and it is of utmost shockproofness. Therefore it is also preferred for the use in mining plants where it has turned out very well in respect to its working reliability.

Another used relay is the robust flat relay. Its advan e against the above mentioned relay is its capability of being equipped with 6 contact springs which, in dependence on requirement, may work as working, rest or change over contacts. The contacts are also rated for a continuous current of 5 A. The relay is of very stable construction and does not fail in its work even under working conditions subject to heavy shock: It is meeting with out any difficulties any demand required i the mining industry.

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My report intended to communicate to you a summarizing survey concerning the construction, operation, and manifold application of the rotary transmitter.

Although the exampls mentioned represent but a small secti of the extensive range of application of the rotary transmitt

they will give you an idea of the numerous problems which can be solved by means of the rotary transmitter.

Although the rotary transmitter, as already mentioned, is a constructional part known for decades of years past it has been used for the industry to a but small extent up to now, and that probably for reasons of its qualities and manysided applications not being sufficiently popularized in industrial circles.

I intended, therefore, to draw your attention by my report to this proved constructional part of communication technics; and I hope that my arguments will contribute to and promote the use of the rotary transmitter to a larger extent than up to now.

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Report: by Chief engineer Mr. Gerhard Thürling

"Electric Appliances and Transmitting Devices for ~~Under~~ Ground Mining"
Above

Contents:

1. General
2. Transmission of orders and transmitting installations
3.1 Order signalling and receiving sets
3.2 Angle position signalling and receiving sets
3.3 Bridge extension signalling and receiving sets
3.4 Wind measuring installation
3.5 Inclination measuring installation
4. Final remarks

Ladies and Gentlemen,

The report on "New electric appliances and transmitting installations for mining above ground" intends to give you an idea of the remote transmission and safety devices used particularly for rubbish conveying bridges and dredging machines respectively.

Special difficulties concerning the sufficient electric and constructional design of the mining devices are offered by the rough working conditions. The acting dust, changing weather in the open air, vapours as well as aggressive water require especially strongly and tightly constructed devices according to the VDE-rules. (Verein Deutscher Elektrotechniker

In order to secure a continuously running and, first of all economical mining work according to latest technical knowledge and experiences the communication and signal installations are progressively improved, resp. perfected as to their development. The devices are not only to increase the safety and diligence of the miners but also, as a final result achieved by the accelerated run of work, to entail a considerable increase of productivity.

The devices are applicable not only in the mining industry but also in rolling plants, in the engineering industry, in the traffic etc.

Modern communication engineering with its manifold application offers nowadays ideal means for adjusting most different working processes to each other in favour of an accelerated run of work on one hand, and for obtaining an utmost work safety on the other hand. The use of all communication plants aims at the retrenchment of idle runs and, in this way, at an increased utilization of the hauling means participating in the winning and conveying work as well as simultaneously at a systematically increased working safety and reliability of any mechanical equipment used.

Everywhere in the industry a continuous and undelayed as well as clear remote indication of certain values, orders or signals is required, resp. technical control and transmitting means are used, as everybody knows, simple, robust special constructional parts and electric switch devices of the communication technics may be employed in the appliances or signalling installations, thus warranting their utmost working reliability.

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Prior to sifting the devices and transmitting installations in question I beg to make some general remarks upon the haulage technics.

1. General

As to the hauling work there was the problem to replace the heavy physical work by mechanical devices, i.e. by machines doing it. The quick promulgation and ingenious utilization of electric engineering has permitted a broad mechanization. Especially the electric machine is capable of concentrating large quantities of energy at spatially limited places, resp. of repeating the same operation for moving heavy masses and loads nearly infinitively often without any fatigue. Such work nowadays is not longer expected to be done by men.

In the line of winning engineering such an example is given by the service of large winning devices - the rubbish conveying bridge and the dredging machine respectively - mechanizing the work to such an extent that, on the contrary to former working methods, only a fraction and insignificant percentage of labours are required who have been set free for new tasks and work.

From the historical point of view the use of the rubbish conveying bridges is still rather new. The first equipment of this kind running on rails has been put to service in Germany in 1924 for winning of lignite above ground, i.e. for removing the facing layers consisting of sand, clay, and other matters. The initially met problems and difficulties have been surmounted already after a short time, and that in a quite satisfactory manner.

Figure No.1 shows a two-sectioned rubbish conveying bridge. The dredging part - to be seen on the left side of the picture - may be displaced against the putting down part (on the right side of the picture) in longitudinal direction. Every rubbish conveying bridge consists in principle of one main bridge with 2 railroad tracks and some secondary bridges as well as

Fig.1 - Rubbish Conveying Bridge

track laying bridge. The delivering conveyors of the dredgers are connected with the main bridge. According to the working conditions the constructional design may be different. On the left side of the picture one scraper and 2 ditchers removing the rubbish are shown. The rubbish is transported, by means of belt conveyors, over the main bridge, and put down on the dump situated on the right side. In the middle we see the bare lignite with the travelling track laid upon it. The span of the travelling gears of a rubbish conveying bridge differs according to the geological conditions in question, and ranges between 80 and 200 ms. The travelling speed of a rubbish conveying bridge amounts to about 6 ms/p.m. In dependence on the working requirements several scrapers and ditchers may be adjoined to one rubbish conveying bridge.

Figure No.2 shows a compound dredging machine. On one side, in front to the left, a ditcher, and in front to the right a slewing scraper are arranged. The dredger runs on rails. In connection with the rubbish conveying bridge preferably slewing dredgers are used. These machines, running partially on caterpillars or also on rails, lead the dredged material through a feeding belt to the rubbish-conveying bridge. Up to now there are different designs and constructions of dredging machines in accordance to the working requirements. Efforts are made, however, to develop a so-called standard design meeting possibly all working requirements in connection with the rubbish conveying bridge.

Fig.2 - Dredging Machine

2. Transmission of Orders and Transmitting Installations

After having surmounted different obstacles and prejudices the rubbish conveying bridges have become the main equipment for transporting the rubbish in the middle German lignite winning industry above ground. Not unjustly the consequences of a heavier accident were feared such a heavy steel construction running on numerous wheels in parallel and perpendicularly to the open mine might be subject to. From the very beginning,

therefore, it has been considered necessary to provide all imaginable safety devices for the plant and for service so as to obviate any danger and accident. The failure of the conveying bridge or of a dredging machine may interrupt the removal of rubbish for a longer time, and result in insufficient utilization of the capacities of the appropriate power plants, briquette factories, and low temperature carbonization plants. For increasing the safety of the operation of the rubbish conveying bridge to the largest extent, and, at the same time, for improving the conveying output communication installations are required permitting improved communications between the control stands (drivers' cabs) as well as the continuous supervision of the entire rubbish conveying work in respect to the working safety and reliability. According to the German Law of Work, dated 19/4/1950, the "Rules concerning the erection and operation of rubbish conveying bridges in open mines" securing the work to be done in adherence to latest technical rules have been published on November 25, 1950. In accordance to these rules all control places should be interconnected by an electric communication equipment so as to permit the clear communication of all orders as well as the confirmation of the receipt of that orders. The sliding motions and angular positions of the travelling rubbish conveying bridge must be clearly and satisfactorily indicated in the drivers' cabs at any time. Large conveying installations, furthermore, should be equipped with reliable wind measuring devices indicating the air pressure. The inclination of the bridge carrier of the rubbish conveying bridge in parallel and perpendicular direction should be controlled by suitable devices. All safety and signalling devices should be wired in adherence to the closed circuit system.

Figure No.3 shows the scheme of a rubbish conveying bridge resting on 2 supports and provided with one ditcher and 2 scrapers. The rubbish is removed from the left side (dredging side) and transported and put down on the dump through belt conveyors. The arrangement and construction as well as the mechanical

Fig.3 - Rubbish Conveying Bridge
(Scheme of Transmitting Installations)

and electric fittings are of essential importance for the output of the machine. Explanations concerning the details of the technical conveying equipment and technical data, however, would exceed the scope of my report.

It is my task to explain the electric communication installations intended for minimizing incidental dangers and accidents by the control of certain parts of the large conveying machines. Upon long years experiences especially the rotary transmitter has turned out best as a special constructional part for the transmitting work of such installations passing on commands and confirming them; the rotary transmitter (electric shaft) excels in quick, reliable, and satisfactory work in A.C.-circuits. This is why for the safety devices of rubbish conveying bridges rotary transmitters - signalling and receiving sets - of certain types an rated for 110 V, 50 cycles, are preferred, due to their simple design and insensibility against mechanical and electric interference

The lower part of figure No.3 shows the top view on a rubbish conveying bridge with schematically marked communication installations on the dredging as well as on the putting down side and located in the drivers' cabs, and involving the following parts;

The order transmitting installation (1, 2) for the communication of orders to the individual drivers' cabs, incl. pole changing switch (3); angular position transmitter with remote indication receiver (4 and 5). The devices are intended to measure the inclined position of the rubbish conveying bri e egainst the travelling gears, and to effect the remote indication of the measured values in the drivers' cabs.

The bridge extension transmitter with remote indication receiver (6 and 7) measures the position of the shiftable bridge carrier of the bucket and dredging chain against the rubbish conveying bridge, and indicates it in the drivers' cabs.

The wind measuring installations, divided into air pressure gauges (8,9,10) and measuring sets for the direction of the wind (11,12,13) with remote indication receivers and recording devices. This installation is one of the most important to be found on rubbish conveying bridges and dredging machines respectively as it warns the service staff so as to make pre-

cautions for protecting the plant from damages caused by storms.

The inclination measuring installation with indication receiver and recording set (14, 15, 16, 17) has to take care of continuously measuring and controlling the occurring longitudinal and transversal inclinations of the travelling rubbish conveying bridge, being capable, moreover, of being used as device for measuring the output of conveyence. This inclination measuring installation will be still discussed in detail in a later part of my report.

The emergency current installation (18) is to secure the necessary supply of current to the wind measuring plant in case the working voltage would fail. All aforesaid installations are energized through a transformer with 110 V, 50 cycles, and work according to the closed circuit system.

Let me give you now a short description of the devices:

3.1 - The transmitter and receiver of orders (figure No.4) consists of a light metal casing with dust proof screwed on cover being the front of the casing. There is provided a dial bearing 15 order sections inscriptions of which are selected according to the requirement of the working conditions of the large conveying machines used. For installing the sets in the desks located in the drivers' cabs they are of similar construction as switchboard instruments. Below the dial there is a small handwheel for adjusting the set to the desired order. Aside the handwheel a small opening is provided through which the no-voltage mark can be observed. The casing contains the signalling and the receiving rotary transmitter as well as the gear wheels for the adjustment of orders and a lifting magnet for the no-voltage mark.

Fig.4 - Transmitter of Orders (closed)

The mode of operation is, in short words, as follows:

When selecting an order by means of the handwheel, through the gear wheels a visible frame pointer is adjusted to the

desired order section. At the same time the rotor of the signalling rotary transmitter is turned by an angle corresponding to that of the order adjusted. When receiving the confirmation of receipt of the order the rotor of the receiving rotary transmitter is operated, thus bringing the little pointer fastened to its shaft into coincidence with the frame pointer. In the event of incidentally failing working voltage, the no-voltage condition is indicated by the red no-voltage mark appearing in the opening aside the handwheel.

The order receiving set consists of a similar light metal casing, and is of same construction as the transmitter of orders. The receiver contains two rotary transmitters and, in addition, a receipt transmitting device consisting of a camdisk and contact springs. This device engages and disengages, through an intermediate relay, the horn circuit. The power input is of about 160 VA.

3.2 The angle position transmitter (figure No.5) is to supervize the torsion of the bridge part and consists of a waterproof light metal casing with a free shaft stump for the drive projecting on one side. A screwed on, hood-like cover takes care of a dust and water proof enclosure of the set protecting one signalling rotary transmitter, the toothed gearing, and 2 cam disks with 2 contacts contained. The contacts are to actuate the alarm device, resp. the disconnecting devices in the event of the inclined position of the bridge reaching certain limits. The lower part of the set bears the terminal box which the outside cable is connected to. The set is installed at the supports of the rubbish conveying bridge. The measuring accuracy is about ± 0.3 %.

Fig.5 - Angle Position Transmitter (closed)

The angle position receiver consist of a steel casing with dust proof cover. The front bears the dial, and the rear wall the connection terminals. The set contains a receiving rotary transmitter and a no-voltage mark lifted by a lifting magnet.

The set power input of which amounts to about 80 VA is installed in the desk of the driver's cab.

3.3 - The bridge extension transmitter is of the same outside shape as the already mentioned angle position transmitter, and of similar inside construction as that set.

The receiver for remote bridge extension indication (fig.6) consists of a steel casing with dust proof bolted cover of light metal having a rectangular opening for the dial. The electric connections are arranged at the rear side of the set. The inside of the set contains a rotary receiver with a small reducing gear moving the pointer in straight and horizontal direction. The set is installed in the driver's cab. The accuracy of indication is 1.5 %. The power input of the bridge extension installation amounts to about 80 VA.

Fig.6 - Bridge Extension Receiver

3.4 - Now some explanations concerning the wind measuring installation with heating device and consisting of the air pressure gauge and the set measuring the direction of the wind would be given. As to this please refer also to our prospectus.

The technical data for the air pressure gauge read as follows:

Measuring range: air pressure: 0 to 110 kgs/m^2
speed of air: 0 to 42 ms/sec.
Measuring error: ±2 % for the air pressure;
Adjustment of cams and contacts: e.g. at 15 ms/sec.) warning
at 20 ms/sec.) contacts
or upon special agreement and in adherence to relevant rules in force.
Working reliability: up to -60°C;
Working voltage: 110 V, 50 cycles;

The air pressure gauge works as follows;
The turnable cup cross is removed from its neutral position, turned by the acting air pressure, by an angle which is proportional to the speed of the wind. The counter torque is effected by a mechanical device with a spring acting on the shaft of the cup cross. The deflection of the shaft of the cup

cross is transferred, through two gear wheels, to the rotary transmitter. For attenuating the air pressure receiving syste in the event of squally wind an oil attenuation is provided. For the release of signals as soon as the adjusted air pressu and the speed of wind respectively are arrived at which are still within the measuring range the mechanical device is equipped with two cam disks permitting, upon suitable adjustment, the operation of contacts actuating the release of the corresponding alarms, resp. disconnecting devices. The cables for the signalling rotary transmitter and for the contacts as well as for the heating are connected by a 13-pole plug. The heating consists of 2 separated tubular heaters of 150 W heating power each. The heating is automatically controlled by means of a thermo-regulator.

The measured values are transmitted to the recording set and the indication receiver respectively.

The dust aluminium casing of the air pressure recorder with hinged cover and 2 T-handles (cp. also our special prospectus) contains a paper transporting gear and the recording gear together with the rotary receiver. The cable for the rotary receiver is led in through a cable bush. The value of deflection proportional to the air pressure is transmitted from the air pressure gauge to the rotary receiver of the recording set. The dial, calibrated in kgs/m^2 for the air pressure, and in ms/sec. for the speed of the wind, is connected with the rotor. The recording carriage is moved, on a guide rail and through a rack, proportionally to the air pressure. For recording the air pressure perforated waxed paper is used. The style fastened to the recording carriage plots the measured values on the calibrated paper strip. The feed of the paper strip is effected, in a speed of 60 mms/hr, by means of a manually wound up eight days clockwork.

The electro-mechanical construction of the indication receivers for the air pressure is similar to that of the aforesaid sets except their special air pressure dial.

For measuring the set of the wind a suitable special device (according to our special prospectus) with a set recording the direction of the wind is provided.

The device for measuring the set of the wind bears in its sectioned aluminium casing a signalling rotary transmitter

connected with the turning vane axle. This shaft can be turned allround, thus being capable of indicating any set of the wind within the range of 0 ... 360 degrees according to the direction of the wind coming from the north, east, south, west, and north again. The device responds at a speed of the wind of about 2 ms/sec. The working voltage is 110 V, 50 cycles. In order to secure the reliable functionning of the device at temperatures of -60°C, for heating pruposes the same heaters as for the air pressure gauge are provided.

An interesting solution for recording the measured set of the wind represents the recording device for such values (cp. our special prospectus). On a gear wheel driven by the rotary receiver 6 styles are uniformly distributed round a circle of 360 degrees. This arrangement permits a continuous motion of the device when recording the measured values. The recording accuracy amounts to about 1.5 %. The styles are marking the set of the wind according to its direction in curved lines and in a satisfactorily visible manner on the waxed paper strip. This paper strip, fed by means of a clockwork, is calibrated, thus permitting to read off immediately the set of the wind.

The wind measuring installation has been designed with a view to manifold applications. The air pressure gauge and the device measuring the set of the wind have been constructed as separate apparatuses. For special purposes the air pressure gauge may be used for recording especially squally winds since it follows any change of the air pressure nearly without any delay of time.

The transmitting installations as briefly described above are used not only for rubbish conveying bridges but also, according to requirement, as special devices for dredging machines, hauling equipments, industrial works and other plants. The design of the sets admits a great number of applications.

An especially new-fashioned and interesting device for measuring the occurring inclinations of large conveying machines is the inclination measuring installation which I am going now to describe in detail.

Allow me firstly to make some remarks concerning the term "inclination" and the relevant motions.

Normally the rubbish conveying bridge runs, as represented in figure No.7a, on tracks laid in parallel to each other and horizontally in different altitudes. According to the working conditions their distance may sometimes vary by several meters. The inclination of the bridge track on the dredging side does not cause any change in the carrying effect, and that in contra-distination to the inclination of the bridge track on the dump side causing motions of the bridge supports and slewing frames.

Fig.7a - Longitudinal Inclination of the Rubbish Conveying Bridge (Scheme)

In the other event the rubbish conveying bridge is able to execute slewing motions whereupon the supporting distance of the bridge carrier may be increased.

All these motions such as the longitudinal (fig.7a) or the transversal (fig.7b) inclination, or the slewing of any parts of the bridge are required for accommodating the rubbish conveying bridge to the geological conditions resulting from variations in the deposit, from changing earth levels etc. Up to now an exact and continuous control of such motions has not been possible except some controlling measurements carried out by the surveyor of mines.

Fig.7b - Transversal Inclination of the Rubbish Conveying Bridge (Scheme)

The problem to be solved, therefore, concerned the continuous measurement of the longitudinal and transversal inclination of a rubbish conveying bridge, and the remote transmission of the measured values to the driver's cab. The measuring accuracy was required to be not less than 0.1 degree i.e. ± 3 arc minutes.

The devices known up to now and consisting in capillary mercury systems, thread pendula and rod pendula respectively are capable of meeting the requirements demanded but imperfectly, or they are nearly unable to do so at all, and that already with a view to the remote transmission of the measured values.

The problem has been solved as follows:

Figure No.8 shows the scheme of an inclination measuring device basing on the effect of a gravitationnl pendulum.(1) In order to obtain a sufficient accuracy the pendulum has been constructed as inertia pendulum For attenuating the occurring vibrations the pendulum is equipped with two containers (2) connected with each other by means of a communicating pipe and filled with a mixture og glycerine. For measuring the deflection from the vertical line an inductive tapping device consisting of an iron segment (3) directly fixed on the inertia pendulum (1), and of a segment with 3 legs and coils (4) is provided which may be turned round the axis of the inertia pendulum. The coil (5) of the middle leg of this segment is energized by an A.C.-voltage serving for exciting the system. The two outside legs bear the control coils (6 and 7). When displacing the coil bearing system (4) against the iron segment (3) a voltage is produced in the oppositely connected control coils (6 and 7) which is used for feeding through a magnet amplifier (8) the control winding of a Ferraris motor (9). The Ferraris motor is connected with the coil bearing segment (4) through a gear. In case of a deflection of the foundation, e.g. due to an inclination of the rubbish conveying bridge, the Ferraris motor of this segment, therefore, will turn it round until its symmetrical position against the vertical is restored again. In this moment the control voltage in the coils gets equal to zero, and the Ferraris motor is stopped.

Fig.8 - Inclination Measuring Installation (Scheme)

The signalling m tary transmitter is driven through a gear (10). The measured values obtained can be transmitted to one

or more indication receivers (11), resp. recording sets (12) over long distances. Apart from this the devices is provided with suitable connecting contacts releasing an audible signal in the event of the inclination exceeding values of 2.1 or - let us say - 2.3 degrees.

The working range of the pendulum is rated, for the time being, to ±5 degrees; according to the working requirements also larger working ranges up to ±10 degrees inclination can be provided. The inclination gauge can be used for measuring both longitudinal and transversal inclinations. The installation of an inclination gauge is recommended especially on the dump side of the bridge where the heaviest inclination effects must be expected.

It should be mentioned else that the inclination gauge as controlling set may be used also for the control of the main belt conveyor, and it has been used in this way already for a longer time where it has burned out well in service.

The control process may be briefly described as follows: Starting from the longitudinal inclination of the rubbish conveying bridge the measured value of inclination takes effec in mechanical way on two potentiometers (13) installed in the set. By turning the sliding fingers of the potentiometers the nearly linear resistance value is altered. The resistance value is transmitted to the power limiting relay (14), and in this way the power and the load admitted by the power limiting relay for the driving motor (15) of the main belt conveyor is determined according to the longitudinal inclination of th rubbish conveying bridge given by the prevailing geological conditions.

In this manner the energy supplied to the motor is rated for the transport, with an ascending main conveying belt, of the same quantities in the same speed as for instance in horizontal direction. That means that scrapers and ditchers respectively are able to work with the same cutting depth, thus taking care of a continuous feed of the material to the main belt conveyor.

According to this the operation of the inclination gauge in connection with the power limiting relay permits the transport of maximum quantities of material by the main belt conveyor, and, in this way, maximum conveying outputs with any

optional inclination of the conveying bridge within the range of - let us say - 1.2 degrees. Without such inclination gauges this has not been possible up to now.

In our prospectus you may find the inclination gauge together with its casing. The height of the set is about 800 mms, the width 550 mms, the depth 280 mms, and the weight amounts to about 75 kgs. On the top you see the dial with the reading-off pointer and graduated, according to working requirement, in degrees (for inclination) or watts (for power indication). For marking the working condition of the set, moreover, a no-voltage mark is provided.

The casing contains the ring-shaped peddulum bearing the necessary constructional parts. On the bottom the magnet amplifier is arranged. By means of a gearing the working range of the pendulum has been extended to a larger reading-off range for the dial.

The inclination gauge, however, can be constructed as conveying power meter, too. In this event a potentiometer device permitting to take effect, by means of the inclination, on the power of the belt conveying installation is installed. In the middle there is the attenuator filled with a mixture of glycerine. The bottom of the pendulum bears the iron device for inductive control. The voltage supply is 110 V, 50 cycles. There are provided, furthermore, connections for the conductors of the alarm circuit.

The indication receiver (see the prospectus) is suitable to manifold applications, and that, according to the graduation of the dial, to the indication of angular positions, air pressures, etc.

The casing accommodating a rotary receiver with pointer is constructed for switchboard mounting. In this case the dial may be graduated, according to requirement and use of the inclination gauge, in degrees or in special cases, if the inclination gauge is used as controlling set, in kilowatts (KW).

The recording set which is already known to you is used in this case, with changed ratio of the gearing, for recording the measured inclination values. The recording accuracy is not less than ± 1 % of the value indicated on the dial (see our prospectus).

According to the working conditions several remote indicatio receivers or recording sets may be connected to the inclination gauge.

4. Final Remarks

The economical importance of the installations explained to you consists in the considerably increased working reliability and safety of large conveying or loading installations, thus effecting also an increase of the output. According to the working conditions the individual devices may be separately installed in the large conveying installations. Except the continuous supervision of the recording sets the attendance to the installations is reduced to a minimum.

The inclination gauge, for instance, is used for the large conveying installations not only as control device for increasing the working safety but also as a regulator considerably increasing the conveying output. The practical results of such increased productivity are ranging at about 25 % above the hitherto conveyed quantities. It is obvious that the installation is redeemed within a very short time. The applications of the inclination gauge, however, are not yet exhausted as they include any use purporting to measure and to record continuously any changing inclination, and to release alarm devices and other operations respectively as soon as certain extents of inclination are reached which have been determined by adjusting the set in advance.

The advantage of the inclination measuring installation consists in the possibility of remote transmission and recording of the values so as to inform continuously the driver of the bridge or dredging machine about the inclination of the large conveying equipment at a time.

By means of the recording critical points of inclination can be recognized so as to make suitable precautions. - With these remarks I beg to finish the description of the individual sets and installations respectively.

In general there should be mentioned else that the described order transmitting and safety devices are based on the hitherto prevailing requirements for safety and operation of large conveying installations. Without any difficulties the suitable sets out of the described devices may be assembled to elektromechanical connections and, according to the working requirements, separately installed in the large conveying installations.

Hoping that you have been able to follow my explanations I beg to finish now my report.

In case there should be some questions else concerning technical matters or the aforesaid communication installations I am ready to reply to them according to my best knowledge.

I thank you for your esteemed attention you have paid to my words.

Literature:

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Photographs

concerning the technical report:

"Electric Applismées and Transmitting Devices for Above Ground Mining"

(Rubbish conveying bridge, dredging machines, cranes, etc.)

Fig.1 - Rubbish conveying bridge

Fig.2 - Dredging machine

Fig.3 - Rubbish conveying bridge (Scheme of Transmitting Installations)

Fig.4 - Transmitter of orders

Fig.5 - Angle position transmitter (closed)

Fig.6 - Bridge extension receiver

Fig.7a - Logitudinal inclincation of the rubbish conveying bridge (scheme)

Fig.7b - Transversal inclincation of the rubbish conveying bridge (scheme)

Fig.8 - Inclination measuring installation (scheme)

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Ladies and Gentlemen,

Introduction:

The report

"New electric signalling installations for under ground mining"

intends to give you a summary on the shaft signalling installations of old and new-fashioned systems for hauling shafts.

After electricity had been introduced in mining work at the end of the nineteenth century there has been recognized that especially the miners working under ground were endangered by accidents resulting from contacts with live parts, and particularly by pit fires caused by the electric current. Precautions for obviating such dangers had to be made, and that by collecting the experiences made as well as by fixing general and special rules upon such experiences (VDE-rules = rules issued by the "Verein Deutscher Elektrotechniker" /Corporation of German Electrical Engineers/). These rules are continuously amended and perfected according to latest technical knowledge.

Special difficulties as to the electric and mechanical construction of the mining sets are offered by the rough working conditions. The effects taken by dust, changing meteorological conditions in the open air, vapours as well as aggressive waters require especially robust and tight constructions in adherence to the aforesaid rules. Further difficulties are met due to the fact that special authoritative prescriptions have to be observed when installing such sets in enterprises endangered by explosions and firedamps respectively. The improved sets are not only to increase the miner's safety and diligence but also to achieve, as the final result, a considerable increase of productivity by accelerating the working process.

The mining sets can be applied also in the chemical industry as well as in other industrial branches. The application of all communication installations aims at the systematical increase of working safety and of the output of the conveying means used for winning and hauling work. In every industrial

place where a clear remote transmission of certain orders and signals respectively is required, as you know, only simple robust, and reliably working special constructional parts and control members are suitable to the use in the sets and signalling installations respectively.

Prior to my entering into the details of such sets and signalling installations allow me please to make some general remarks on the success hauling is aiming at.

1) General

The hauling work in the mining industry includes not only the hoisting of the material won under ground such as ores, coal, potassium and other minerals to the surface but also the bringing down of machines and goods of any kind.

The increasing depths of the shafts, and the necessity to increase also the loads to be lifted result in special attention to the fitting of the shafts with suitably designed banks - unloading place - (at the mouth of the shaft above ground) and shaft stations - loading places -(on the lowest floor) together with their appropriate equipment. The special task for the pit eye is to convert the horizontal conveyance from the worked stratum into the vertical haulage through the shaft. When answering the important question for the correct selection of the point at the surface where a new shaft is to be sunk ("deepened" or "driven") the prevailing conditions of the deposit as well as the working conditions above and under ground should be considered. The cross section of the shaft performance and sectioning of which is called the "cross section of pit" may be rectangular, square, circular, elliptical, or limited by depressed arches.

The deepest shaft in Germany being sunk down to a depth of 1200 ms is situated near the town Hamm. In the Southafrican gold mining industry depths (deepnesses) of about 2600 ms have been reached.

The shafts representing for under ground mines the only transportation way to the surface they have to meet a number of different requirements. They are used not only for the haulage of goods but also for the descent and ascent of the miners (man-ride), for the ventilation, for the descent of mine props, machines and materials of any kind, for the installation of the required water and compressed air lines as

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well as the electric high and low voltage cables.

In such a shaft, according to the working requirement, mostly 2 drawing cages with several floors receiving the miners' trucks (dogs) can be accomodated. In special cases combined cages are provided, i.e. with one part being the dray (kibble) and with a compartment for the miners.

The cages are moved up and down, by means of a rope, by a hauling engine an with maximum speeds up to 20 ms/sec. equal to 72 kms/hr.

For man-rides the cage speed is considerably reduced amounting to not more than about 8 ms/sec. corresponding to about 30 kms/hr.

From such considerations you may gather that - besides the haulage installations - the signalling devices are of substantial importance for the drawing work so as to secure - besides the clear and satisfactory communication - the safety and economy of the whole hauling service. The shaft is the only tubular connection with the surface of ground.

Above the pitmouth the whim tower is erected (fig.1) being of most different construction according to the prevailing working conditions. The picture shows a whim tower with two head wheels arranged above each other. On the left side the wire rope can be seen which the cages running in their guides are fastened to. The wir rope is driven by the hauling engine through a pulley. Below the head wheels you may see a part of the shaft frame with the guide rails for the cages.

Fig.1 - Whim Tower

(- [redacted] -)

1 - Bank;
2 - Ground bank;
3 - First floor;
4 - Intermediate floor (Pump house);
5 - Second floor (plot);
6 - Hauling engine house;
7 - Main stop;
8 - Auxiliary stop;
9 - Stops;

The example of a main shaft (fig.2) shall explain to you the construction and the normal signal connections of the stops between the floors and the cellar, the bank with platforms as well as the hauling engine house. On the right side of the picture a scheme of the hauling

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(- [redacted] -)

10 - Signal receiving device;
11 - Section through the shaft tube with platforms and cellars;
12 - Cellar;
13 - Hauling cage;
14 - Platform;

Fig.2 - Hauling Shaft (Scheme)

engine room with the signal receiving device (signalling column) for the operator of the hauling engine is to be seen. For the shaf tube according to the requirement of work the following fittings are provided:

The bank arranged in an altitude of about 20 ms above the pit mouth serving for the transport of the won materials and for the execution of man-rides.

The ground bank, resp. ground floor is mostly used for the descent and ascent of machines or their parts, of mine props etc. This bank is preferably arranged on ground level directl above the pit mouth.

The first floor of this example is assumed to be in a depth of about 300 ms.

Below this the intermediate floor for the accommodation of pumping sets and other machinery is arranged.

The second floor, being also the loading place, is assumed to be arranged in a depth of about 600 ms. On this floor the won minerals are loaded as well as the different goods transporte and for carrying out the man-rides cellars of several floors are there arranged, thus permitting, for saving time, the miners to enter and to leave all floors of the cage at the same time.

The number of floors of the hauling shaft mostly depends on the geological and working conditions on site.

At the control points at the grate gate of the shaft the necessary stops (jacks) transmitting the signals are arranged The main stop is the bank. Our example shows a frame winding system with 2 multi-storied cages. The platforms and cellars being mostly used for man-rides only are equipped, for this reason, with secondary stops belonging to the appropriate main stops. Accordung to the rules in force in the moment of the transmission of signals only the floor the cage has arriv at may be in connection with the bank. The remaining floors must be disconnected.

As to the communication during the hauling service by mean of signals the following requirements should be considered:

1) The communication between the plot or the intermediate floor and the bank.

2) The communication between the bank and the operator of the hauling engine.

3) The communication between a random place within the shaft and the bank or the operator of the hauling engine, e.g. in the event of maintenance work in the shaft.

These conditions are explained in detail in the special rules "Concerning the erection, testing, attendance and repair of electric signalling installations in main and other shafts between galleries with man-ride equipment"(Rules for shaft signalling technics) which are obligatory in Germany.

2) Signalling Methodics.

The signalling process for hauling services comprises the following principal parts:
the call, the assignment and indication, the announcement and execution,
resulting in the following signalling circuits (fig.3):

(- [redacted] -)

1 - Calling;
2 - Assignment and Indication;
3 - Announcement;
4 - Hanging-on;
5 - Ready for hauling;
6 - Execution;
7 - Hauling engine room (signal column);
8 - Bank;
9 - First floor;
10- Second floor (pit eye);
11- Transmitter (stop);
12- Receiver;
13- Scheme of the Signalling Circuits in the Shaft Tube.

Fig.3 - Signalling Circuits (Scheme)

a) The call is effected from the floors to the bank.

b) The assignment and indication are effected from the bank, and the indication is transmitted to the floors and to the hauling engine room.

c) The announcement (e.g. man-ride, material, self-acting ride and other kinds of hauling service) may be effected according to two methods:

1) From the bank to the floors with incidental receipt signalled from there to the hauling engine room.

2) From the floors to the bank with incidental receipt signalled from there, thus giving announcement to the hauling engine room.

d) The execution signal orders the hauling engine driver to start the hauling engine.

1) The hanging-on signals are principally given from the floor to the bank, and from the bank to the hauling engine driver in form of bell signals.
2) The signal "ready for hauling" is mostly used for the execution of the haulage of goods or for man-rides. The circuit for the transmission of such signals can be connected in several ways:
   a) One signal impulse with storage from the floor to the hauling engine driver,
   b) the second signal impulse from the bank to the hauling engine driver, or at first from the bank to the hauling engine driver and from the floor to the hauling engine driver, or both signal impulses at the same time.

The transmission of signals by the hanging-on signalling installation giving bell signals between the onsetters in the shaft and the hauling engine driver through pull keys and according to a fixed signalling system is the most preferred communication method up to now.

In Germany denote:
as announcing signal (determination of the kind of haulage)
4 strokes of a clock - slow ride,
5 " " - man-ride,
6 " " - self-acting ride etc.;
as execution signal (for starting and stopping the cage)
1 stroke of a clock - stop,
2 strokes " " - up
3 " " " - hang up

The transmission of signals by strokes of clocks has been maintained since the introduction of electricity in the mining industry in 1890. Such signals, however, may lead again and again to errors and misunderstandings, especially in the event of numerous groups of signals existing, thus entailing deplorable accidents and failures in service.

3) Different Systems of Shaft Signalling Installations

Two examples are intended to explain to you the signalling installations normally in operation in France and with us in Germany. Let us firstly have a short look at a French shaft signalling installation (fig.4).

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(- [redacted] r)

1 - The lamp annunciator for the signalling equipment;
2 - Switchboard with push buttons for the signalling equipment;
3 - Signal box indicating the kind of haulage;
4 - Pull switch;
5 - Bell signal;
6 - Alarm contact;
7 - Bank + 11 ms;
8 - Hauling engine room;
9 - Bank 0 m level;
10- Depth of floor -240 m;
11- Electric Signalling Installation - France, 1952.

Fig.4 - Electric Signalling Installation - France, 1952

The picture shows a multi-floor mine. On the right side the hauling engine room with the signal receiving devices is indicated including: The lamp annunciator for the signalling equipment (1) and the switchboard with the push button for the signalling equipment (2). There are installed, furthermore, bells, horns, and other switch devices.

On the top of the left side you see the bank arranged in an altitude of 11 ms above the pit mouth with the lamp annunciator (1), the signal box indicating the kind of haulage (3), the push key (4), the hanging-on signal (bell signal) (5), the alarm contact (emergency signal) (6), and, furthermore, the appropriate switch devices.

Below this the bank (level bank) arranged in an altitude of 0 m, and provided with similar signalling apparatuses and devices is installed.

On the left side of the bottom the pit eye is indicated which is equipped with similar installations and devices as briefly described above.

The current feeding the signalling installation with 110 V, 50 cycles, is taken, through a transformer 220/110 V from the feed line of the hauling engines.

The signals themselves are given as follows: the haulage announcing signals are light signals with following indications

Personell = Personel; Minéral = Ore;
Matérial = Material; Visite = Inspection.

Each of the most important words is divided into as many sections as there are signalling pieces concerned. Let us describe, as an example, the transmission of the signal "Personell" assuming the level bank of 0 ms altitude and the pit eye (floor) being in service. Upon communication between these two onsetting points the section "Per" or "nell" will light in all lamp annunciators incl. the first bank above ground. The acoustic devices for the pit eye and the level bank are

actuated for a short time. The onsetter, e.g. on the floor, gives his consent by operating the push button of his signal box. Now the other section of the word, and that "nell" or "Per" will light on all lamp annunciators showing now the partial word "Per - nell". The accordingly informed hauling engine driver now adjusts his speed lever to the signal "Free for hauling" for the word "Personell". In this moment the remaining section "so" will light. In this way the signal "Personell" is completely indicated on the lamp annunciators by the onsetter and the hauling engine driver. Other kinds of haulage such as "Material" etc. are announced in accordance to similar procedures.

The execution signal for starting the hauling engine is given by successive strokes of a clock according to a similar code like in Germany, and that:

1 stroke of the clock = stop,
2 strokes of the clock = free for haulage of ore or material,
3 strokes of the clock = descent,
4 strokes of the clock = ascent,
5 strokes of the clock = free for man-ride.

The bell signal is given by means of the pull key. You may gather from this example that French signalling methodics lay special stress upon the use of lamp annunciators to largest extent. The audible execution signals similar to those used with us in Germany serve as additional determination of the kind of haulage and indicate the lift and the descent of the cage.

By the next example I shall explain to you the signalling installations which have been used for years in German mining shafts (fig.5).

(- Vokabularium Abb.5: -)

1 - Bank;
2 - Hauling engine room;
3 - Level bank;
4 - Floor;
5 - Electric Signalling Installation in Germany

Fig.5 - Electric Signalling Installation (Germany)

On the right side of the picture you see the hauling engine room with the signal receiving equipment consisting of several lamp annunciators, acoustic devices, bells, horns, and various switch devices.

On the left side of the top of the picture the bank can be seen. The main onsetting point is fitted with several lamp annunciators, pull keys for the hanging-on

signalling device, the button "ready for hauling" for the appropriate signalling device, the emergency button with horn as well as switches and telephones.

Below the bank there is the level bank fitted with installations similar to those provided for the bank.

On the bottom of the picture a floor - in our example simultaneously representing a pit eye - is shown. The equipment provided for the onsetting place of the floor is nearly the same as that the level bank is fitted with.

The great number of the sets results from the fact that according to working conditions the signalling installations, e.g. for "man-ride" and "haulage of goods" are separately constructed and installed. In principle the signalling plants consist of several parts:

a) the hanging-on signal (signals by means of strokes of a clock),

b) the signal "ready for hauling" (visible and audible),

c) the emergency signal,

d) the shaft signal,

and, in addition, the telephone equipment as well as the bad earth control and the corresponding feed of current. The signalling installations give nearly exclusively audible signs, i.e. the signals of announcement and execution consist of groups of strokes of a clock.

From these two shortly explained examples you may learn that the transmission of audible signals as used up to now should be completed, due to their insufficient working safety, by installations giving visible signals. Owing to the not insignificant difficulties met in connection with the hauling service the transmission of visible signals is introduced more and more since it offers utmost safety as optical signals can be clearly perceived and understood.

Thorough examinations of the signalling methodics prevailing up to now resulted in the discernment that, though all bell signals probably cannot be put aside, it is quite possible to restrict them exclusively to the execution signals (start signals for moving the cage). Basing on such knowledge already shortly before the war in Germany designs of shaft signalling installations working according to the signalling-back-method were revised taking, in the German Democratic Republic, a new-fashioned way, and that by carrying out the transmission of

signals by means of remote indication devices using preferably a special constructional part - the rotary transmitter.

4) New Shaft Signalling Sets with Rotary Transmitters

The following description of the rotary transmitter shaft signalling installation (fig.6) with the appropriate sets is predominantly confined to sets and devices which have been recently developed by the "VEB Funkwerk Berlin-Köpenick".

(- [redacted] -)

1 - Bank;
2 - Hauling engine room;
3 - Level bank (ground floor);
4 - First to fifth floor;
5 - Rotary Transmitter Shaft Signalling Installation.

Fig.6 - Rotary Transmitter Shaft Signalling Installation (Scheme)

On the right side of the picture we see the scheme of the hauling engine room with the signalling column and the stand of the hauling engine driver with the appropriate switchboard. To the left of the picture there is the bank with the main hanging-on place where the signal transmitter with the pull key (execution key), a lamp annunciator for the three visible and audible execution signals and another lamp annunciator for the floor indication are mounted. Below the floor assignment switch as well as, on the right side, the stop switch for the inter-floor-traffic are arranged. To the right of the signal transmitter the emergency button and, on the other side, the telephone are located. Above the sets the bells as well as the horn are mounted. The connecting cables run to the distribution boxes.

Below the bank there is the level bank, resp. ground floor. Here a reduced number of sets are installed. In the middle there is the signal receiver with the pull key to the right and the calling button to the left.

The under ground floors are fitted with similar sets as the level bank.

For connecting the hanging-on places in the shaft tube a lead-sheathed rubber cable according to VDE 0870, table 17, should be installed. This cable also contains the telephone conductors. For a multi-floor-mine a shaft signalling cable of about 45 signal conductors is required.

The rotary transmitter shaft signalling installation comprises the following individual sets connected by cables:

1. the announcement signal transmitter for the bank
2. the announcement signal receiver for the floor
3. the signalling column with the signalling sets installed:
   - 3.1 projector for the announcement signals
   - 3.2 electric bell signalling device for the execution signals
   - 3.3 signalling device "ready for hauling" with two-stroke system
   - 3.4 emergency signalling device (optical and acoustic)
   - 3.5 connection for the automatic speed limitation of the hauling engine (in the event of man-rides)
   - 3.6 connection for the hauling engine stop device (in the event of shaft gates existing)
   - 3.7 connection for the electric speed recorder with speed indication
   - 3.8 connection for the floor assignment indication
   - 3.9 connection for the stop indication (required for inter-floor-traffic)
4. the brake lever switch for switching off the optical signals. The switch is attached to the brake lever of the hauling engine, and adapted and adjusted according to the nature of the brake lever.

Apart from this there must be installed: the signal change-over switch and the device change-over switch which are mostly arranged for being under the control of the hauling engine driver, and, furthermore, the floor change-over switch and the stop switch arranged on the bank onsetter's stand as well as the bells and horns respectively.

For transmitting the announcement signals by means of rotary transmitters the shaft signalling installation is energized by 110 V A.C. of 50 cycles; for special technical reasons the execution signals receive the supply of 110 V D.C.

By means of the signal change-over switch - preferably installed on the hauling engine driver's stand the following signalling circuits can be switched on:

a) the onsetting signalling device with the announcement signal
b) the signalling device "ready for hauling" with the announcement signal
c) the hauling signal and, according to working conditions, the transmission of signals from the level bank, resp. ground floor instead of the bank.

The installation throw switch permits - in the event of failures - only the transition from the optical-acoustic signalling plant to the simple audible transmission of signals.

The individual sets of the rotary transmitter shaft signalling installation have the following construction and operate as follows:

Let us consider firstly the signal transmitter for the bank (fig.7). The robust grey cast casing is of flame and explosion proof design. The width of the casing amounts to about 500 mms, the height to about 600 mms, the depth to about 350 mms. The weight is about 85 kgs. The front bears a protected dial of 17 sections marked with the different kinds of haulage like man-ride, haulage, material, self-acting ride etc. Two red pointers can be moved over the dial. By means of the hand wheel the large frame pointer is adjusted to the desired sector of the dial. In this moment a bell is ringing on the floor as well as in the hauling engine room. The onsetter in the floor gives receipt by adjusting the small red pointer to the announcement signal called for on his signal receiver as indicated by the frame pointer. In this way the kind of haulage like e.g. "man-ride with platform" is optically indicated by the corresponding positions of the pointers at all onsetting places of the shaft.

Fig.7 - Signal Transmitter for the Bank (with Execution Key

In the hauling engine room the signal "man-ride with platform" is lighted and, furthermore, the hauling speed limiting device automatically connected to the hauling engine. The automatic speed limiting device cannot be switched on or off unless the brake of the hauling engine is put on. Furthermore the platform lamps are lighted, thus simultaneously switching on the local platform signalling device, resp. that for the cellar automatically. The signal transmitter and receiver respectively are fitted with indicator lamps. On the left side of the casing there is a lamp for the onsetting signalling device, on the other side a lamp for the signalling device "ready for hauling" with another lamp arranged above. On the right side of the casing the pull key for the signal hanging-on and ready respectively (execution signal) is located.

On the bearing block of the signal transmitter the rotary signalling and signal receiving transmitters rated for 110 V A.C. of 50 cycles together with the receipting contact are fitted. At this place, moreover, the switch contact for engaging and disengaging the speed limiting device for the hauling engine is arranged. In the casing to the right the contact for the execution key and "ready"-key respectivly is mounted. The inside of the cover bears the gear wheels with stop spring connecting the handwheel with the rotary signalling transmitter. Cover and casing are flame proof tightened. To the terminals of the cable connecting box the signalling cable having 24 conductors of 1,5 mm^2 cross sectional area each and coming from the distribution box is connected.

The signal receiver (fig.8) for the floor consists of a cast casing similar to that of the transmitter on the bank, and bears, in addition, on the left side the call button in order to enable the onsetter on the floor to call for him being assigned from the bank in accordance to requirements of service. The assignment can be recognized by the operation of the floor lamp (SoL).

In the middle of the signal receiver the rotary signalling and receiving set are mounted. On the left side the contact for the call button, and on the right side that for the execution button are arranged. A robust flat relay rated for 110 V is to actuate the signal receiver as soon as the relevant floor is assigned. The cable connection is similar to that of the signalling transmitter mounted on the bank. The same is true as to the connection between the handwheel and the rotary signalling transmitter.

Fig.8 - Signal Receiver for the Floor (with call and execution button)

The signalling column (see our prospectus) indicates the signals to the hauling engine driver. For better intelligence exceptionally all light fields have been switched on. Under normal working conditions always only the fields required for

for the corresponding signals will light. In the signalling column the initially mentioned constructional groups of special constructional members and relays required for improved control and attendance are installed as interchangeable units. Following radient fields are provided:

a) "Locked" and "Free" for the hauling engine stop device in dependence of the shaft gates.
b) "Stop" for the emergency signal.
c) "Announcement signals" for indication of the kind of hauling
d) "Ready" for the "ready"-signal.
e) "Execution signals" as light spot indication.
f) "Floor assignment" for 1 to 5 floors in maximum (the long vertical radient field on the left side).
g) "Stop indication" (inter-floor-traffic) (the long vertical radient field on the right side).
h) "Readiness lamps" indicating the readiness of the signallin installation to work.

The middle of the signalling column is intended for accommodating the electric speed recorder for speeds up to 18 ms/s.

The signalling column is accessible from both sides and from the rear wall. It contains, moreover, the fuse members and the connections for the signalling cable.

For exstinguishing the optical execution signals together with the start or stop of the hauling engine the "brake lever switch" is provided. Through a toothed gearing and camshafts the contacts automatically opening and closing the circuit for the execution signals are operated. This device is mechanically connected with the brake lever of the hauling engine.

The electric power for the signalling installation is taken from the feed line of the hauling engine. The feeding device consists of one transformer with two rectifiers out of which one serves as stand-by unit. The power input of the installation depends on the number of floors to be served and amounts in average to about 700 VA for the D.C.-supply of 110 V, and to about 700 VA for the A.C.-supply of 110 V.

5) Explanations of the Signalling Processes in Hauling Service

Following some examples now the signalling processes carried out by means of the rotary transmitter shaft signalling installation shall be explained in detail. The first example

is to show man-rides, and that using the signals "Man-ride" or "Man-ride with platform" with the hanging-on signalling device.

For this purpose the signal throw switch is adjusted by the hauling engine driver to the hanging-on signalling device. On the signal receiver (fig.9) the signalling procedure is indicated by a lamp (MSE). The onsetter on the second floor wants to start the haulage to the bank. For this purpose he operates the call button and calls the bank. Upon the ringing of the calling bell the onsetter of the bank assigns the signal receiver to the second floor. In this moment the working lamp and at the same time the floor lamp (Sof.) of the signal receiver will light. The onsetter of the second floor now adjusts, by means of the handwheel, the frame pointer to the dial sector "Man-ride" or "Man-ride with platform". The onsetter of the bank gives receipt for this signal. In the signalling column of the hauling engine room the announcing signal "Man-ride" or "Man-ride with platform" appears. At the same time the signal lamps for the circuit of the platform signal lamps and, moreover, the connection of the speed limiting device for the hauling engine are switched on and is closed respectively. Now the onsetter of the second floor gives the execution signal "Up" by pressing twice the execution button = releasing two strokes of the clock. The execution signals can be transmitted only in the sequence from the onsetter of the floor to that of the bank and further from there to the hauling engine driver. For reason of such signalling dependence the onsetter of the bank is not able to transmit other execution signals than those received from the floor. On certain working conditions, however, this signalling dependence can be abolished. The execution signal "Up" is indicated on the bank in optical and audible manner.

Fig.9 - Signal Receiver ("Man-ride"-position)

The onsetter on the bank transmits the execution signal "Up" to the hauling engine driver, and in the signalling column (fig.10) the signal becomes visible by two light spots; at the same time the clock is rung by two strokes. On the signalling column the following signals can be recognized:

a) the announcing signal "Man-ride" or "Man-ride with platform";
b) the execution signal "Up" = two strokes of the clock;
c) the floor assignment: 2nd floor.

Now the hauling engine driver may start the hauling engine. As soon as the driver moves the brake lever the execution signals will become extincted. Wrong signals can be cancelled by operating the emergency button.

Fig.10 - Signalling Column (ready for "Man-ride")

Another example represents the "haulage" using the "ready"-signalling installation. The signal throw switch with the hauling engine driver is adjusted to the corresponding positi

The announcing signal "haulage" has been given through the rotary transmitters. The onsetter of the bank has finished the charging the cage and operates once the right "ready"-button. In this moment the green lamp on the right side of the signal transmitter (FL will light. The signalling impulse reches the signalling column where it is stored. The onsetter of the second floor has carried out the same operations, and in this way the signal "ready for hauling" is released.

Fig.11 - Signal Transmitter (ready for "Haulage"

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In the moment of the ready-signal arriving at the signalling column (fig.12) there will light the radient field "Ready" in green colour, and the "ready"-bell will ring two times. In the announcement signalling field, moreover, the signal "Haulage" appears. In the floor assignment field, furthermore, the "2nd floor" is indicated. When the brake lever is released the ready-signal disappears again. In the event of the ready-signal being given with released brake, or the armature of a relay or a contact failing the emergency signal will work for five seconds. Emergency signal buttons for being operated in case of danger are installed at any onsetting place.

Fig.12 - Signalling Column (ready for "Haulage")

Also in the event of wrong or uncomplete transmission of signals the emergency signal may be operated.

The third example is to show the step indication in case of inter-floor-haulage if the cage is to transport "material" from the first to the second floor. The step signals are given according to the following sequence:
stopping place - announcing signal - execution signal.
The onsetter of the 1st floor adjusts the frame pointer of his signal receiver (fig.13) by means of the handwheel to the 2nd floor. The onsetter of the bank who has signalling connection with the 1st floor gives receipt to this order, and adjusts the step switch to the 2nd floor. - Now the onsetter of the 1st floor adjusts the announcing signal "Material" which is also receipted by the bank onsetter.

Fig.13 - Signal Receiver (ready for "Material")

On the signalling column (fig.14) at the hauling engine driver's stan now the following signalling fields will light:

a) the announcing signal "Material"
b) the assignment signal for the 1st floor (on the left side)
c) the stop indication for the 2nd floor (on the right side).

The exectuion signals "Hang on" given in the meantime by drawing the pull key three times are also indicated on the signalling column by three light spots, and simultaneously by three strokes of the bell

Fig.14 - Signalling Column (ready for "Material")

In this way the stop of the cage in the event of inter-floor-traffic is clearly indicated. The hauling engine is started, and the execution signals become extincted. Now the bank onsetter disconnects the first floor by means of the floor change-over switch, and makes the connection with the second floor. According to such procedure most different signals can be transmitted.

Hoping to have made you understand the signalling installation and its operation by the pictures and the examples given I beg to point out now in summary the following advantages of the rotary transmitter shaft signalling installation as compared with other signalling systems:

1) A.C.-voltage supply of 110 V and 50 cycles for the announcing and secondary signals. For the execution signals, i.e. the signals for starting the cage, the D.C.-voltage of 110 V has been maintained.
2) The hitherto prevailing bell signals are reduced as in future the visible and visible and audible indication will be preferred for the announcing and execution signals.
3) The three execution signals (starting orders)
   one stroke of the clock = Stop,
   two strokes of the clock = Up
   three strokes of the clock = Hanging
   are transmitted, in dependance on each other, from the onsetter of the floor to that of the bank, and from there to the hauling engine driver. Upon special working con-

ditions this dependence can be abolished. The interlocked transmission of signals prevents any further misunderstandings.

4) In case the cabetting signalling installation is replaced by the ready signalling plant after the operation of the change-over switch the same signal buttons of the signal transmitter and receiver respectively as before are used. For reasons of working requirement special signal buttons can be provided immediately at the shaft gate. The connected signalling system is always indicated by corresponding lamps the signal transmitters and receivers as well as the hauling engine room are equipped with.

5) For the connection of the automatic speed limiting device switching cams acting on the hauling speed through a suitable connecting device of the hauling engine are provided in the signal transmitter. Equally to this for "Man-ride with platform" the local platform signalling equipment is switched on, too.

6) The stop signal for inter-floor-traffic in future can be given also according to special signalling methodics by means of the signal transmitter and receiver respectively, and indicated on corresponding indication fields.

The aforesaid kinds of operation are in accordance with the shaft signalling rules in force in Germany and with the technical conditions prescribed therein.

6) Final Remarks

The new-fashioned signalling methodics, and the work of the rotary transmitter shaft signalling installation have been subject since about one year to practical experience in our copper mines.

Fig.15 shows the signalling column aside the mechanical depth indicator of the hauling engine. It is totally enclosed and its front is in a distance of about four metres from the hauling engine driver.

Fig.15 - Signalling Column in the Hauling Engine Room (Copper Mines)

The switch desk located on the driver's stand contains the built-in signal throw switch for selecting the desired signalling system. Behind this switch there is the installation throw switch permitting, in the event of incidental failures of the optical-acoustic signalling installation, the transitic to the only audibly working bell signalling plant. The front of the casing bears the signalling lamps indicating the working positions of the switch.

Fig.16 shows the bank onsetter operating the different sets of the signalling equipment. On the left side the signal transmitter, (and that a type without signalling lamps, mounted. Above this set there is the optical light spot indicator for the execution signals. The distribution boxes are installed aside of this indicator. On the right side the telephone and, above this, the acoustic sets (bells etc.) are arranged.

Fig.16 - Rotary Transmitter Shaft Signalling Installation (Copper Mine)

In this moment (fig.17) the floor onsetter adjusts the signal receiver to the announcing signal "Haulage". In front of the miner the operating levers for the hydraulic truck conveying device at the shaft gate are arranged.

The experts of the copper mine who have continuously used this shaft signalling installation for some time past have pronounced their opinion upon the work of this plant. Here are some extracts from such judgments:

Fig.17 - Floor Signal Receiver (Copper Mine)

"As to its functionning the installation has turned out well The operation being easily understood does not require a great

deal of the working staff. The visible and the audible indication considerably increases the safety, and the service staff has confidence in this installation. The signalling installation, furthermore, is of considerable influence on the production. The hauling capacity of the shaft, as compared with the quantities reached up to then, could be increased, especially when using the ready-signalling method, by about 7 %. Failures of signals are hardly to be reckoned with, even in the event of a part of the installation failing. The various change-over possibilities always permit to continue the hauling work. The installation has surpassed the results expected, and is meeting all requirements asked for."

This is the reading of the extract from the judgment given by the copper mine experts. The rotary transmitter signalling installation is suitable to mines with 1 to 5 floors, and that as to both cage and skip hoisting systems. It is adapted to the nature of the shaft hauling work in question, and special demands can be considered accordingly.

It will be interesting for you, furthermore, that the signalling installations should be fitted with recording sets to the largest possible extent. For such purpose we are experiencing, for the time being, a new electric speed recorder consisting of the following parts:

1) the A.C.-speedometer machine with speed gearing to be attached to the hauling engine;
2) the speed indicator for 0 ... 18 ms/sec. installed in the signalling column;
3) the electric recording device with the registering set for recording of:
   a) the speed curve (hauling speed of the hauling engine),
   b) the execution signals (onsetting and ready-signal),
   c) the anouncing signals (e.g. man-ride, haulage, slow run),
   d) the emergency signal.

This briefly described recording device is, as already mentioned, still in state of being tested; upon finished tests the production will be started.

The connections for such sets being already provided in the signalling column their later attachment can be done without any difficulties. Furthermore an electric depth indicator with optical flush indication intended for indicating the descent

and the assemt of the cages at the bank and, during the hauling process, to the hauling engine driver, is in state of development.

My report on the construction and work of the shaft signalling devices was to give you a certain idea of signalling methodies used for hauling shafts. According to practical prooves the rotary transmitter signalling installation secures a nearly perfectly safe and reliable transmission of signals. The operation of the sets by the onsetter and the clear indication of the signals are offering especially to the hauling engine driver a high degree of safety for his work at the hauling engine.

Also in future we shall go on to make all efforts for increasing the miner's safety and, in connection with this, for facilitating his responsible work.

Thanking for your esteemed attention now I beg to finish my report.

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